DESCRIPTION OF THE SKULL OF MEGAPTERA MIOCAENA, A FOSSIL HUMPBACK WHALE FROM THE MIOCENE DIATOMACEOUS EARTH OF LOMPOC, CALIFORNIA.[1]

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INTRODUCTION.

In the summer of 1919 the United States National Museum received through the United States Geological Survey a skull of a Miocene whale, which had been presented by the Celite Products Company, Lompoc, California. More recently the writer was enabled to visit this particular locality, and through the courtesy of E. B. Starr and Edward J. Porteous, of the company, he was shown the exact position where the skull was excavated. The beds of diatomaceous earth at Lompoc furnish a very extensive marine fauna, composed mainly of fishes and to a less extent of birds, cetaceans, and pinnipeds. A very interesting account of the locality has recently been published by David Starr Jordan.[2]

In preparing to study the Tertiary Cetacea of the Pacific coast of North America, the writer had occasion to examine the literature relating to the described forms. The two principal accounts of the finding of fossil whales of the family Balaenopteridae in California are very brief, and without having examined the original specimens one can not be certain that the identifications are correct. In 1872 Cope[3] recorded the occurrence of *Eschrichitus davidsonii* in a formation assumed to be of Miocene Age at San Diego, California. Some years later Stephen Bowers[4] announced the discovery of *Escrichtius davidsoni* [=? *Balaenoptera davidsoni* Scammon[5]] associated with other Pleistocene mammals at Ventura, California.

[1] This paper has been prepared in the course of a study on the fossil cetaceans of the Pacific coast and is published here in advance of a final monograph on the subject. This study has been made possible by a grant from the Carnegie Institution of Washington and is being carried on under the direction of Dr. John C. Merriam.

[2] Jordan, D. S., A Miocene catastrophe, Natural History, vol. 20, no. 1, pp. 18–22, with illus., New York, Jan.–Feb., 1920.

[3] Cope, E. D., Proc. Acad. Nat. Sci. Philadelphia, pp. 29–30, 1872.

[4] Bowers, S., American Geologist, vol. 4, p. 391, 1889.

[5] Scammon, C. M., Proc. Calif. Acad. Sci., vol. 4, no. 20, pp. 269–270, San Francisco, Oct. 4, 1872.

On account of the early coosification of nearly all the bones in the basicranium and the obliteration of the sutures, it is usually difficult in adult skulls to determine their margins and relations. This skull (Cat. No. 10300, U.S.N.M.) belonged to an immature individual and fortunately some of the sutures are still visible. Most of the fossil genera allied to *Megaptera* are based either upon mandibles or vertebrae, and since this form is known only from a skull no comparisons are made with any of the previously described forms. It is by no means certain, however, that some of the previously proposed genera allied to *Megaptera* are valid, and in this connection attention is directed to the two following closely related, if not identical genera: *Megapteropsis robustus* [6] was proposed by Van Beneden for a mandible found at Wyneghem, Belgium, while a nearly complete vertebral column from Antwerp was designated by the same author as the type of *Burtinopsis similis*.[7] These two genera were considered by Herluf Winge [8] to be identical with the genus *Megaptera*.

The discovery of this Miocene member of the Mystacoceti gives additional force to the views of those who have advocated the great antiquity of the Cetacea. It is now evident that a highly specialized humpback whale existed during the Lower Miocene off the Pacific Coast of North America, which affords further evidence for assuming that the evolution of the Cetacea has taken a longer period than has heretofore been considered plausible because of certain anatomical characters possessed by the living cetaceans.[9] Along this line there is considerable evidence from the structure of the periotic which, although not conclusive, is at least strongly suggestive. It is stated by Gray [10] that "in both the Cetacea and the Sirenia the cochlea is of a very primitive type." Further study of the auditory apparatus of whales may reveal some interesting evidence bearing on the antiquity of these forms.

Megaptera miocaena is based upon an incomplete skull in which the anterior half of the rostrum and part of the right side of the skull were cut off and lost, the block containing that portion having been carted off to the brick plant before the true nature of the find was fully known. The ventral surface of the skull is crushed in across the palatal region, and some of the thinner bones are so brittle and soft that they disintegrated during shipment from the field to Washington.

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[6] Van Beneden, P. J., Bull. Acad. Roy. Sci. de Belgique, ser. 2, vol. 34, p. 15, Brussels, 1872.

[7] Idem, pp. 19–20.

[8] Winge, H., Vidensk. Meddel. fra den naturhist. Foren. i Kjøbenhavn for 1909, pp. 1–38, 1910.

[9] Weber, M., Die Saugetiere, pp. 126, 562, 571, 580–582, Jena, 1904.

[10] Gray, A. A., The labyrinth of animals, vol. 2, pp. 22–23, London, 1908.

I am indebted to Mr. Charles W. Gilmore, of the Department of Vertebrate Palaeontology of the United States National Museum, for the opportunity to describe this specimen, and wish to express my cordial thanks to him for this privilege and for the kindly interest he has shown. The drawings in the text have been carefully made by Mrs. Frieda Abernathy, under the supervision of Mr. E. L. Furlong.

DESCRIPTION OF SPECIES.

MEGAPTERA MIOCAENA, new species.

Type.—Cat. No. 10300, U.S.N.M. This specimen consists of an incomplete skull, including the posterior (cranial) region, the squamosals, the supraorbital processes of the frontals, and the posterior half of the maxilla on the left side. The palatal region and the scaphoid fossae are imperfect, while most of the rostrum as well as the maxilla on the right side are missing. The external side of the right tympanic was badly broken, though a sufficient number of fragments were located to enable accurate restoration of this element. The right periotic is practically perfect.

Type locality.—In uncharted township one-half mile northwest of northeast corner of township 6 north, range 34 west (Lompoc Quadrangle), on top of divide between drainage of San Miguelito Creek and Salsipuedes Creek, 3 miles south and east of Lompoc, Santa Barbara County, California.

Horizon.—The skull was first discovered by workmen quarrying diatomaceous earth, about 150 feet below the exposed surface of the bed. As considerable erosion had occurred at this point and as the beds are approximately 1,000 feet thick, it will be impossible to state the exact level until the base of the bed is reached in the course of operations of the Celite Products Company. These beds of diatomaceous earth are considered to be equivalent to the Temblor or Lower Miocene. This specimen was excavated and packed for shipment to Washington, District of Columbia, on July 15, 1919, by W. S. W. Kew, of the United States Geological Survey, assisted by Edward J. Porteous, of the Celite Products Company.

SKULL.

In the present paper it is proposed to give a detailed description of certain bones in the skull. As will be observed from the description, this skull exhibits some interesting characters for a humpback whale. In comparison with other members of the Balaenopteridae, the skull (pl. 1) is remarkably broad and flat when viewed from below, approaching *Megaptera nodosa* more closely than any other known fossil or living whale.

The most obvious peculiarity of this skull is the relatively greater width of the rostrum, which, instead of being narrow and tapering, as in *Megaptera nodosa*, is proportionately broader at the base and possibly slightly shorter. This inference is drawn from the curvature of the rostrum as seen from a dorsal view. The preorbital and postorbital portions of the supraorbital process of the frontal do not over-roll the optic fossa so completely in *Megaptera nodosa.* In the latter form the internal portion of this fossa is completely roofed over by these processes. The exoccipitals are rather large and rounded, while in the skull of the living humpback whale they are somewhat compressed; their appearance in the latter indicates that in the course of time they have become reduced in size and flattened up against the external auditory meatus on the squamosal. The descending lateral processes of the basioccipital are considerably developed, appearing much more conspicuous than in the living forms of *Megaptera.* The tympanic and periotic of the living humpback whale, *Megaptera nodosa*, exhibit only minor modifications of the type that is found in this Miocene *Megaptera.*

MAXILLAE.

The maxilla is a very large bone, whose dorsal plate forms the greater part of the rostrum and whose ventral plate takes a prominent part in roofing over the oral cavity. On the dorsal surface it does not extend posteriorly beyond the base of the nasals. The internal margin of the dorsal plate is in contact with the premaxilla for almost the entire length, receiving the facial process of the latter in a shallow groove along the edge, though this groove is restricted to the posterior end of the maxilla.

The lateral border of the maxilla is thin and bladelike, differing here but slightly in contour as well as in general proportions from *Megaptera nodosa.* In ventral view, the posterior extremity of the maxilla is observed to be very thin, ending in a sharp-edged plate. Pressure exerted by the overlying beds has crushed in the center of this skull, and as a result this portion of the maxilla is closely appressed to the supraorbital process of the frontal. In a perfect skull this part of the maxilla will no doubt be found to be very much like that in a skull of *Megaptera nodosa* (Cat. No. 21492, U.S.N.M.), which was figured by True.[11] This horizontal ventral plate of the maxilla is marked by shallow curved grooves for lodging the bases of the blades of baleen which depend from the roof of the mouth. Just anterior to the preorbital process at the lateral extremity of the supraorbital there is present an indentation in the maxilla for the reception of the jugal. The latter is missing in this specimen,

[11] True, F. W., The whalebone whales of the western North Atlantic, Smithsonian Contrib. to Knowledge, vol. 33, pl. 30, fig. 2, Washington, D. C., 1904.

and the zygoma has been restored on plate 2 from a recent *Megaptera nodosa*. No trace of an alveolar gutter for rudimentary teeth can be found along the lateral margin of the maxilla.

PREMAXILLAE.

The premaxillae are more slender than *Megaptera nodosa*, but are otherwise closely similar so far as can be determined from the fragments which were preserved with the skull. Posteriorly these bones send back long facial processes, which are lodged in grooves on the upper internal margins of the maxillae, as well as in deep paired grooves on the anterior margin of the combined frontals. The premaxillae are bent downward internally as they approach the nasals, being closely appressed to the maxillae, and form in this region the lateral borders of the nasal openings.

NASALS.

In most respects the nasal is similar to that of *Megaptera nodosa*. It is short in proportion to the length of the rostrum, concave from side to side, and curves ventrally. The free extremity of the nasal is slightly expanded and abruptly truncated. The paired nasals form the posterior border of the nasal openings.

FRONTALS.

The frontals are much reduced in extent on the vertex, being overridden by the supraoccipital posteriorly and the maxillae and nasals anteriorly. In a middle line in front the combined frontals send forward a wedge-shaped process which separates the nasals posteriorly, and on the left side external to this process there are present two deep grooves, separated by a thin septum, for lodging the posterior end of the premaxilla. Laterally the frontals suddenly widen out to form broad and massive supraorbital processes, though at a lower level than the vertex, and afford complete osseous roofs for the orbits. The supraorbital process slopes forward; its posterior margin is greatly thickened and curves sharply downward at right angles to the roof.

Ventrally the preorbital and postorbital processes are prolonged downward in a gentle convex curve inclosing the optic fossa. The postorbital margin of the supraorbital process is prolonged into a thin ventrally directed plate, though it apparently did not meet the blunter and similarly directed plate of the preorbital margin to arch over completely the optic fossa. A further difference from *Megaptera nodosa* lies in the exposure of the optic surface of this element for its whole extent, even though there is a conspicuous overrolling on the part of both preorbital and postorbital plates, with the result that the orbital roof is reduced to a narrow triangle on the external half. The descending process of the frontal, a continuation of the preorbital plate, does not abut against the external pterygoid.

The floor of the orbit can only be surmised by a comparison with *Megaptera nodosa*, since both jugals are wanting.

SUPRAOCCIPITAL.

As a whole the occipital region narrows toward the vertex. The supraoccipital by itself forms practically the entire posterior and upper part of the skull roof, extending up to the vertex to meet the frontals; in the middle line it bears a low, flattened ridge, which is plainly visible even though the supraoccipital has been slightly crushed anteriorly. The ridge is more conspicuous and increases in prominence toward the condyles, while it stops before reaching the frontals. On either side of this low ridge, the supraoccipital is gently concave from side to side. The parietals are in contact inferiorly with its lateral borders.

PARIETALS.

From a dorsal view the parietals are barely visible on the top of the skull, their median parts being concealed by the protruding edges of the supraoccipital. They do not enter the vertex and appear in the temporal fossae as narrow wedge-shaped bones partially limited anteriorly by the supraorbital processes of the frontals and ventrally by the external pterygoids. However, the parietal does override the frontal above the great supraorbital expansion of this bone for some distance forward, extending beyond the vertex.

The parietal of *Megaptera miocaena*, like that of *Megaptera nodosa*, is in contact with the glenoid process of the squamosal, the superior margin of the external pterygoid process of the alisphenoid, and overrides the supraorbital process of the frontal.

ALISPHENOID.

As a result of a careful study of three skulls of *Megaptera nodosa*, one a very old adult (Cat. No. 14409, U.S.N.M.), the second a mature individual (Cat. No. 21492, U.S.N.M.), and the third a young female (Cat. No. 17252, U.S.N.M.), it was concluded that the ala temporalis, or alisphenoid, is excluded from the temporal fossa by the inferior margin of the parietal overlapping its exposed surface. The examination of a skull of a young *Balaenoptera* in which the sutures were still visible confirms this assumption to some extent.

A close examination of the relative outlines of the various elements forming the internal wall of the temporal fossa of this fossil whale adds additional support to this view. The sutures of the small wedgelike ala temporalis, or alisphenoid, in the right temporal fossa are nearly obliterated, while the same element on the left side had either coalesced with the parietal or is concealed by it.

OCCIPITAL CONDYLES.

The occipital condyles, which project considerably and are borne on very short condylar processes, are relatively large, equaling in general proportions those of *Megaptera nodosa.* They are subhemispherical in outline, uniformly convex dorso-ventrally, and the internal margins gradually converge ventrally. The vertical diameter is almost twice that of the horizontal. The external margins of the condyles are set off from the exoccipitals by shallow concavities and the condyles themselves slope strongly from the internal to external margins.

EXOCCIPITALS.

The exoccipitals comprise the greater portion of the posterior end of the skull. Above they are coalesced with the supraoccipital, and laterally they are in contact with the posterior margins of the squamosals, while below they are fused internally with the basioccipital. The exoccipitals are large and rounded, appearing much more massive than those of *Megaptera nodosa.*

BASIOCCIPITAL.

The basioccipital, on account of the knoblike lateral processes, bears a close resemblance to the same element in the basicranium of *Rhachianectes glaucus.* It is a very broad bone, with ventral surface concave from side to side, and is terminated posteriorly by the paired occipital condyles. The anterior margin is ankylosed to the basisphenoid. The sutures between the basioccipital and exoccipital are closed, making it very difficult to determine their boundaries. On each side anteriorly there descends from this element an expanded and rounded process, which serves as part of the external wall for the tympano-periotic cavity. In this respect, it resembles *Rhachianectes glaucus.* Anteriorly these rounded processes are in contact with the vaginal processes of the internal pterygoids.

SQUAMOSALS.

The squamosal is exceedingly large, firmly fixed to the side of the skull, and internally forms part of the wall for the cranial cavity. In ventral view, the posterior and outer part of the squamosal is produced downward into a great trihedral pillar. The glenoid surface of the squamosal is wide and concave from side to side. The rounded and heavy postglenoid process is directed more downward than backward. Behind the glenoid surface the squamosal exhibits a comparatively low, and folded-backward bladelike ridge, between which and the trihedral pillar is a broad, deep channel, while behind this ridge, or rather between it and the exoccipital, there is a shallower and narrower groove concealed by the aforementioned

ridge. This broad, deep channel on the squamosal posterior to the glenoid surface is the groove for the external auditory meatus, which continues its course outward by winding around the postglenoid process of that bone. The stout zygomatic process projects laterally and anteriorly to articulate with the jugal and with the postorbital process of the frontal. The petrous portion of the squamosal overrides the descending lateral wing of the basisphenoid.

BASISPHENOID.

The basisphenoid is a wholly flat bone, probably entirely concealed by the expanded wings of the vomer. By removing a portion of the overlying vomer it was found that the presphenoid is permanently separated from the basisphenoid by an open transverse suture. Two horizontal processes arise from the anterior end of the basisphenoid, one of which is the ala temporalis; the other appears on the surface of the temporal fossa as the external pterygoid. The descending lateral wing of the basisphenoid unites with the petrous portion of the squamosal to form the anterior margin of the tympano-periotic recess.

VOMER.

Since one side of the palate has been destroyed, one is permitted to trace the course of the vomer for most of its extent. The vomer, judging from the exposed surface on the right side of the skull, is more expanded in the rostral region, where the maxillae abut upon it by their rounded margins, than near the palatines, where the former have commenced to conceal it with their marginal plates. The curvature and outlines of a section of the vomer, 14 inches in length from the rostral region, bears out this impression.

The vomer, which presumably was partially concealed by the palatines, again makes its appearance at the point where these bones commence to diverge from one another. It is characterized here by a prominent carina similar to that which separates the palatines in the living *Megaptera nodosa*, while posteriorly it gradually diminishes in height toward the base. The loss of the posterior margin of the vomer prevents the determination of the point where the carina disappears. Laterally the vomer is in contact with the vaginal processes of the internal pterygoids.

PALATINES.

It is difficult from the present specimen to secure anything like an adequate idea of the shape or relationships of the palatines to the adjoining bones. The skull has been considerably crushed inferiorly in the palatal region, as mentioned previously, and as a result the maxillary-palatine sutures and the true outlines of the palatines are somewhat obliterated. The imperfectly preserved palatine over-

rides the carina of the vomer to a greater degree than is normal in *Megaptera nodosa*, and may possibly have been fused medially to its adjoining mate. A careful comparison of this palatine with the same element in skulls of *Megaptera* and *Balaenoptera* shows that this coalescence is a modification of rare occurrence except possibly in *Balaenoptera borealis.*

PTERYGOIDS.

The pterygoids are apparently the most delicate bones in the basicranial region of the skull, and for this reason they are often found to be damaged in fossil specimens. The imperfect state of preservation of the scaphoid fossae of this skull prevents one from describing with any degree of certainty the correct outlines of the bones forming the ventral surfaces.

These fossae are large and well defined, ovoidal in outline and comparable in size to those of a young *Megaptera nodosa.* It is stated by von Schulte [12] that the so-called pterygoid fossa can not correctly be called such in *Balaenoptera borealis* and that this cavity should be known as the scaphoid fossa.

The internal pterygoid commences posteriorly at the anterior margin of the lateral swelling of the basioccipital and is bounded internally by the expanded wings of the vomer. The hamular processes on both sides are destroyed, though the curvature of the descending portion of the internal pterygoids at the fracture indicates that they curved internally and horizontally. The roof of the scaphoid fossa is formed in part by the internal pterygoid, though this element is so intimately ankylosed to the external pterygoid process of the alisphenoid that accurate determination of their boundaries is impossible. Von Schulte's statement, as well as his figures [13] of the external pterygoid process of the alisphenoid in the embryo of *Balaenoptera borealis*, are of unusual interest in view of the fact that previous workers considered this element to be the ala temporalis, or alisphenoid. In the nasal fossa the vaginal process of the internal pterygoid plate is joined to the vomer by suture.

In the temporal fossa the external pterygoid process of alisphenoid joins by suture the vertical plate of the palatine and is in contact with the postorbital process of the supraorbital. The foramen ovale is situated in an aperture formed between the diverging glenoid and the falciform processes of the squamosal at their line of union with the posterior termination of the external pterygoid process of the alisphenoid, and more internally is partially bounded by the descending lateral wing of the basisphenoid. The external pterygoid process probably forms the floor of the scaphoid fossa.

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[12] Schulte, H. von W., Anatomy of a foetus of *Balaenoptera borealis,* Mem. Amer. Mus. Nat. Hist., n. s., vol. 1, pt. 6, pp. 476–477, New York, March, 1916.

[13] Idem, p. 476, pl. 44, fig. 2.

Just posterior to the scaphoid fossa is a funnel-shaped recess which enters the cranial cavity. It is bounded internally by a conspicuous lateral swelling of the basioccipital, which forms a rounded knob; posteriorly by the exoccipital; and externally by the squamosal. In this cavity the fused tympanic and periotic is lodged.

A well-marked groove leads downward from this cavity, follows the external side of the basioccipital, and makes a deep groove in the exoccipital, where it terminates on the surface. This is the large posterior lacerated foramen.

FIG. 1.—DORSAL VIEW OF RIGHT PERIOTIC OF MEGAPTERA MIOCAENA × 1, CAT. NO. 10300, U. S. N. M.; LOMPOC, CALIFORNIA.

PERIOTIC.

As it is not the object of the present paper to go into an explanation of the homologies of the elements comprising the periotic, a discussion of this is omitted, and the terminology adopted is based upon the work of Lillie [14] in 1910.

The periotic bone is irregularly V shaped, the apex or opisthotic is not complete, while the anterior, or proötic, resembles a compressed three-sided pyramid. On the dorsal face (fig. 1) the proötic is separated from the labyrinthic region by a broad and

[14] Lillie, D. G., Observations on the anatomy and general biology of some members of the larger Cetacea. Proc. Zool. Soc. London for 1910, pp. 769–792, pl. 74, text figs. 69–78 [discussion of auditory organ of *Balaenoptera*, pp. 775–781, text figs. 71–72, pl. 74].

rather deep groove, into which the inner edge of the wedge-shaped ridge, formed by the fused processes of the basisphenoid and squamosal, is received, and which in turn serves to lodge the periotic more firmly. The dorsal surface of the proötic is closely applied to the petrous portion of the squamosal, while the anterior margin is in contact with the external pterygoid process of the alisphenoid.

The proötic is not clearly differentiated from the opisthotic, for these elements are so fused as to be unrecognizable as separate elements.

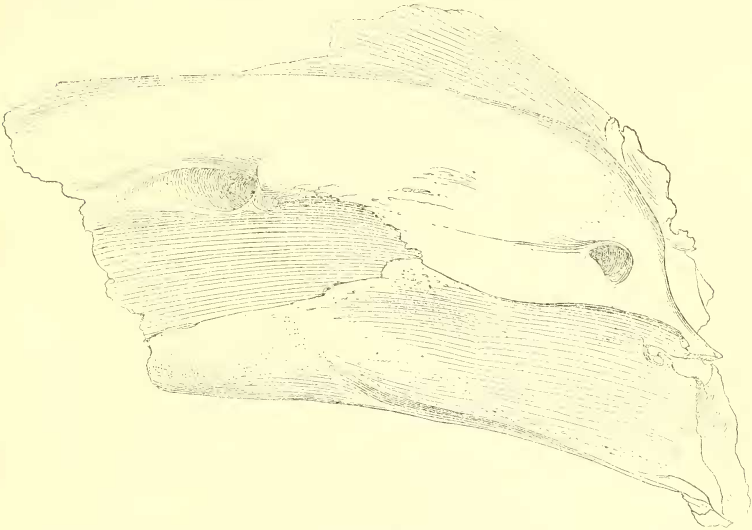


Fig. 2.—Posterior view of left periotic of Megaptera nodosa × 1, Cat. No. 21492, U.S.N.M.; Cape Cod, Massachusetts.

The posterior process or opisthotic, as previously mentioned, was broken off when the periotic was removed from the skull for study. The apophysis of the opisthotic fits snugly into the groove that lies just posterior to the open channel for the external auditory meatus. It was impossible to remove the apophysis without doing serious damage to the skull and hence it was not figured with the remainder of the periotic bone. The entire external prolongation of the opisthotic of *Megaptera nodosa* is not shown in figures 2 or 4.

On the ventral face of the proötic (fig. 3), near the posterior end, there is a rounded depression to which the pedicle of the anterior extremity of the tympanic bone is ankylosed. According to previous investigators, it would appear that the processus gracilis of the malleus is fused with a rounded projection on the tympanic near the posterior end. As most of the posterior pedicle is wanting on both

of these fossil tympanics, this bone will not be discussed further. In figure 5 the posterior pedicle has been restored to show its relations with the periotic. However, the posterior pedicle is somewhat shorter than is shown in this figure for it rests against the inferior surface of the apophysis of the periotic and not against the broken base of that process as shown in figure 5. No incus was found with this auditory apparatus. Doran,[15] in his notable memoir on the ossicula auditus, figures the incus of *Balaenoptera mysticetus* (pl. 62, fig. 29), but states that he has neither examined nor found a detailed description of the incus of *Megaptera*.[16]

FIG. 3.—VENTRAL VIEW OF RIGHT PERIOTIC OF MEGAPTERA MIOCAENA × 1, CAT. NO. 10300, U.S.N.M.; LOMPOC, CALIFORNIA.

A long, slender stapes is present in the fenestra ovalis of the right periotic (fig. 6), which is more slender and relatively longer than that of *Balaenoptera physalus*. No stapes of *Megaptera* was available for comparison. The base of the stapes is soldered to the fenestra ovalis. An effort was made to dislodge this bone for accurate study, but this plan was given up when it became evident that such a procedure would probably result in the breaking or destruction of the stapes. The head of the stapes is oval. The crura are long and fairly straight, while the aperture is smaller than in *Balaenoptera physalus*, or *B. musculus*.

[15] Doran, Alban H. G., Morphology of the mamalian ossicula auditus, Trans. Linnean Soc. London, ser. 2, vol. 1, pt. 7, pp. 371–497, pls. 58–64.
[16] Idem, p. 455.

Just behind the depression for lodging the pedicle of the tympanic is the facial canal, a groove running in a transverse direction, which is very similar in position and shape to that of *Megaptera nodosa.* In fact, there is a striking similarity between the entire periotic of *Megaptera nodosa* and the same bone of this fossil. The central or labyrinthic portion of the periotic which incloses the essential part of the auditory organ is so nearly like the corresponding structure in the periotic of *Megaptera nodosa* that a description of

FIG. 4.—VENTRAL VIEW OF LEFT PERIOTIC OF MEGAPTERA NODOSA × 1, CAT. NO. 21492, U.S.N.M.; CAPE COD, MASSACHUSETTS.

one could well apply to the other. The inferior surface of this labyrinthic region is dome shaped. On the posterior surface of this dome there is a slight depression formed in part by the aperture of the fenestra rotundum. A rounded ridge projecting over the internal margin of the facial canal marks the external boundary of the labyrinthic. This same ridge in *Megaptera nodosa* (fig. 4) is considerably flattened posteriorly as well as internally, and forms a floor which extends nearly halfway across the canal. The apertures for the eustachian tube and for the fenestra ovalis in this fossil are

FIG. 5.—POSTERIOR VIEW OF RIGHT TYMPANIC AND PERIOTIC OF MEGAPTERA MIOCAENA IN POSITION × 1, CAT. NO. 10300, U.S.N.M.; LOMPOC, CALIFORNIA.

FIG. 6.—LOOKING INTO THE VESTIBULE FROM APEX OF RIGHT PERIOTIC OF MEGAPTERA MIOCAENA × 1, CAT, NO. 10300, U.S.N.M.; LOMPOC, CALIFORNIA.

practically identical in position with those of *Megaptera nodosa.* A similar ridge separates these apertures.

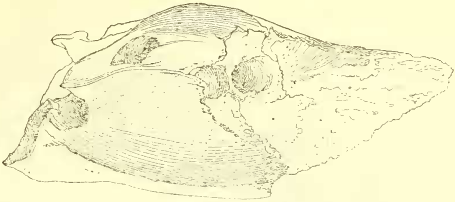


FIG. 7.—POSTERIOR VIEW OF RIGHT PERIOTIC OF MEGAPTERA MIOCAENA × 1, CAT. NO. 10300, U.S.N.M.; LOMPOC, CALIFORNIA.

TYMPANIC.

The tympanic bone is relatively dense and heavy, fastened to the periotic by two thin pedicles (fig. 8) and connected with the fenestra ovalis by a chain of ossicles. In shape and general proportions (fig. 9) it resembles that of *Megaptera nodosa*, though it is, of course, slightly smaller. The outer surface is nearly subquadrate in outline. It differs from *Megaptera nodosa* in the following details:

FIG. 8.—EXTERNAL VIEW OF LEFT TYMPANIC OF MEGAPTERA MIOCAENA, ABOUT NATURAL SIZE, CAT. NO. 10300, U.S.N.M.; LOMPOC, CALIFORNIA.

The posterior face is indented medially. The anterior face slopes obliquely forward to the external side, while in *Megaptera nodosa*

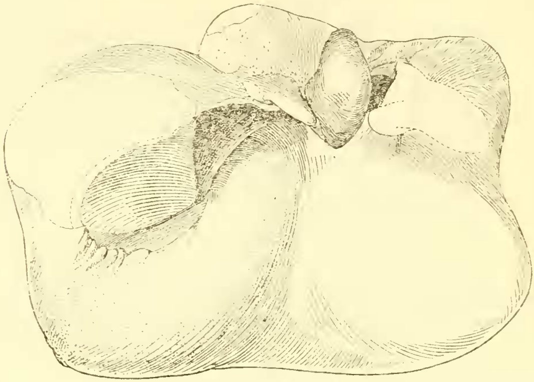


FIG. 9.—DORSAL VIEW OF LEFT TYMPANIC OF MEGAPTERA MIOCAENA, ABOUT NATURAL SIZE, CAT. NO. 10300, U.S.N.M.; LOMPOC, CALIFORNIA.

the reverse is true; that is, it slopes obliquely from the external to the internal side. In outline the external side resembles that of the

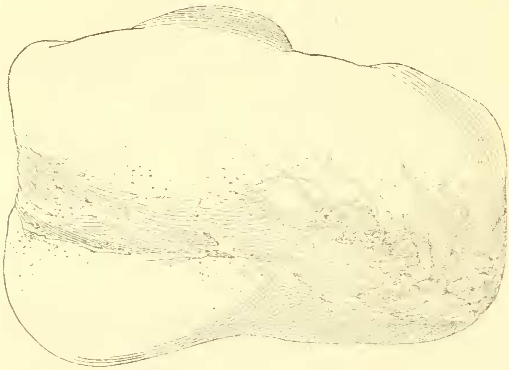


FIG. 10.—INTERNAL VIEW OF LEFT TYMPANIC OF MEGAPTERA MIOCAENA, ABOUT NATURAL SIZE, CAT. NO. 10300, U.S.N.M.; LOMPOC, CALIFORNIA.

living species, except that in the latter the posterior corner is more abruptly truncated.

TABLE OF MEASUREMENTS.

	Mm.
Breadth of skull across anterior ends of zygomatic processes of squamosals	1,216
Greatest breadth of skull across lateral margins of exoccipitals	788
Greatest transverse width of temporal fossa	388
Greatest antero-posterior width of temporal fossa	167
Greatest ventral length of supraorbital process	461
Greatest antero-posterior diameter of orbit	159
Greatest length of palatine (estimated)	460
Greatest width of basioccipital between tympano-periotic recesses	273
Greatest width between bases of lateral descending processes of basioccipital	88
Greatest antero-posterior length of combined scaphoid and tympano-periotic recess	215
Greatest transverse width of scaphoid fossa	92
Greatest dorso-ventral diameter of condyle	180
Greatest transverse diameter of condyle	101
Breadth of rostrum at base (estimated)	876
Distance from anterior end of nasals to anterior edge of frontals	224
Greatest length of tympanic bulla	93
Greatest width of tympanic bulla	60
Greatest depth of bulla on internal side	50
Greatest depth of periotic in labyrinthic region	35.5
Greatest antero-posterior length of periotic	86
Greatest extero-internal width of periotic	81

EXPLANATION OF PLATES.

Plate 1.

Ventral view of skull of *Megaptera miocaena*. Cat. No. 10300, U.S.N.M., Vert. Palaeon. Type. The right periotic lies in its normal position. The right supraorbital fragment is not placed in its correct position in this plate.

Plate 2.

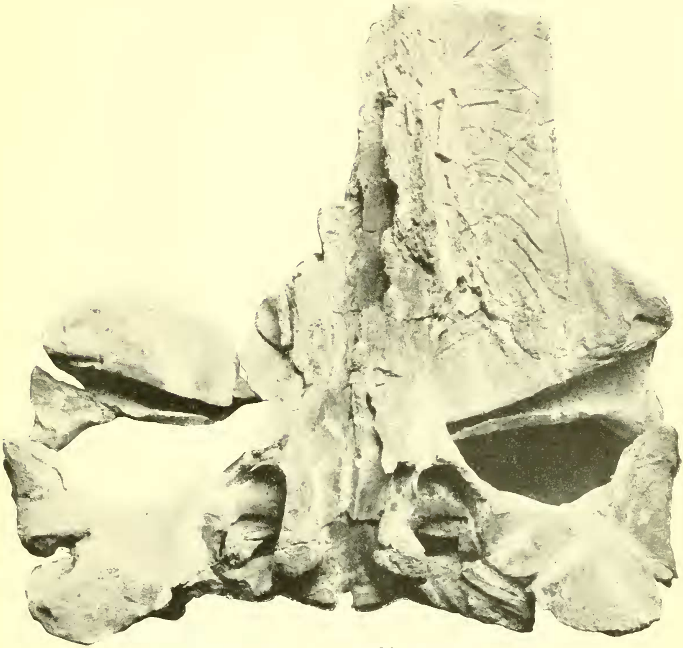
Diagrammatic outline drawing of ventral view of skull of *Megaptera miocaena*. The right side has been restored to show approximate outlines of the missing parts.

Plate 3.

Dorsal view of skull of *Megaptera miocaena*. Cat. No. 10300, U.S.N.M., Vert. Palaeon. Type.

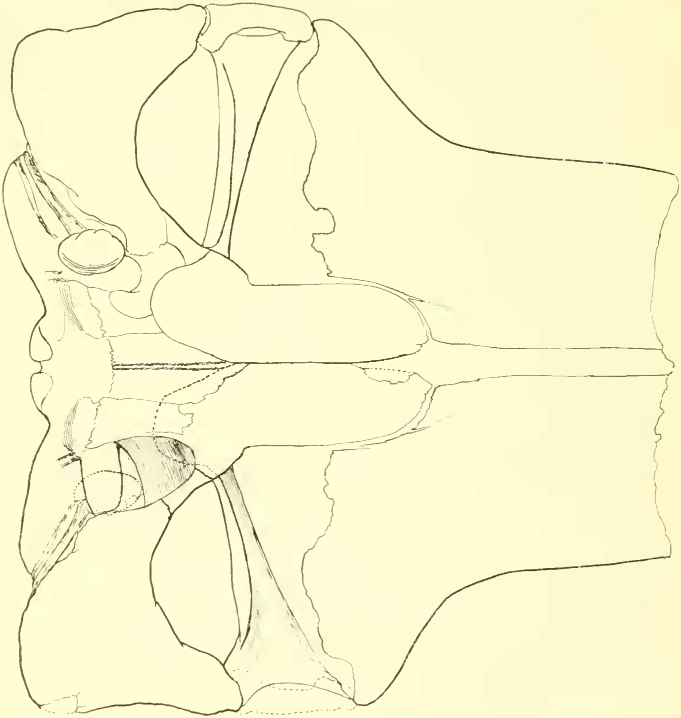
Plate 4.

Lateral view of skull of *Megaptera Miocaena*. Cat. No. 10300, U.S.N.M., Vert. Palaeon. Type.



VENTRAL VIEW OF SKULL OF MEGAPTERA MIOCAENA.

FOR EXPLANATION OF PLATE SEE PAGE 13.

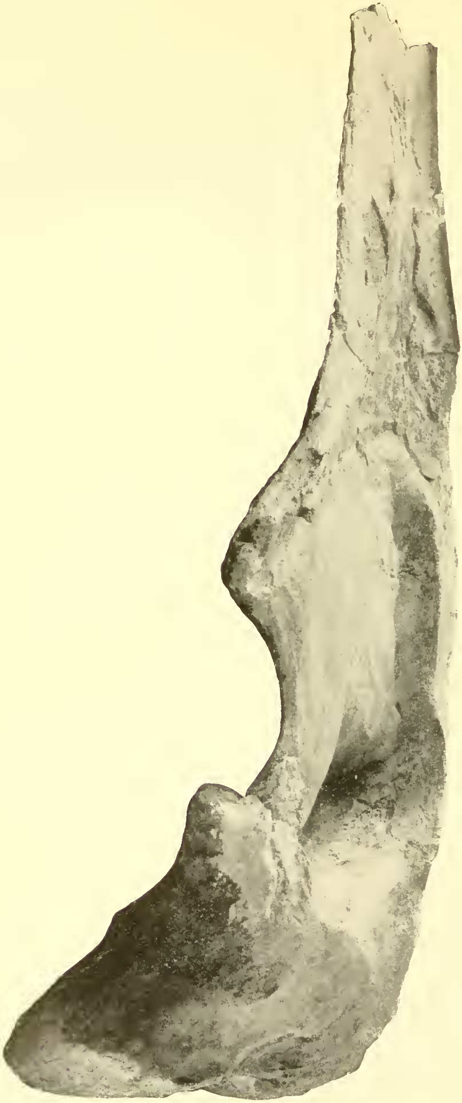


OUTLINE DRAWING OF VENTRAL VIEW OF SKULL OF MEGAPTERA MIOCAENA.

FOR EXPLANATION OF PLATE SEE PAGE 18.

DORSAL VIEW OF SKULL OF MEGAPTERA MIOCAENA.

FOR EXPLANATION OF PLATE SEE PAGE 18



LATERAL VIEW OF SKULL OF MEGAPTERA MIOCAENA.

FOR EXPLANATION OF PLATE SEE PAGE 18